West Nile Virus in Montana

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West Nile Virus in Montana

- **Mosquitoes**
  - **Trapping & vector ecology**
- **WNV**
  - **Introduction & movement**
  - **Transmission**
  - **Immunity**
  - **Impacts**
- **Mosquito management**
- **A guess at the future**

Mosquitoes

- **WNV Statewide Surveillance 2003 – present**
  - **Species composition**
  - **Seasonal abundance**
  - **Distribution**
  - **Monitoring WNV activity**
- **Primary vector is *Culex tarsalis***

(Hale. 2007. MS thesis. MSU., Friesen and Johnson. 2013. Med Vet Ent.)

Species	+/tested
Cx. tarsalis	134/389
Ae. vexans	3/136
Cu. inornata	1/57
Cx. pipiens	0/53
Aedes spp.	0/12
Anopheles spp.	0/10
Cx. salinarius	0/1
Total	138/658

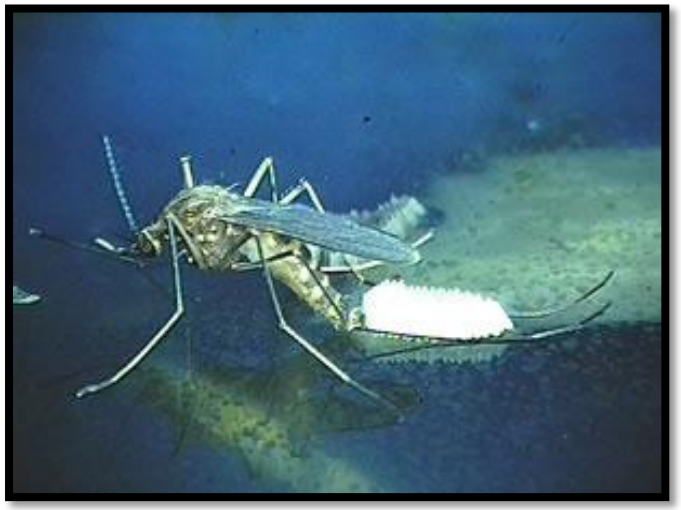
Culex tarsalis

- **Widely distributed in the Great Plains and western US**
- **LT catches <20% of total**
- **Associated with riparian zones, wetlands, irrigated hay/grass production**
- **Detected in most areas of Montana**
- **Higher densities east of Continental Divide**

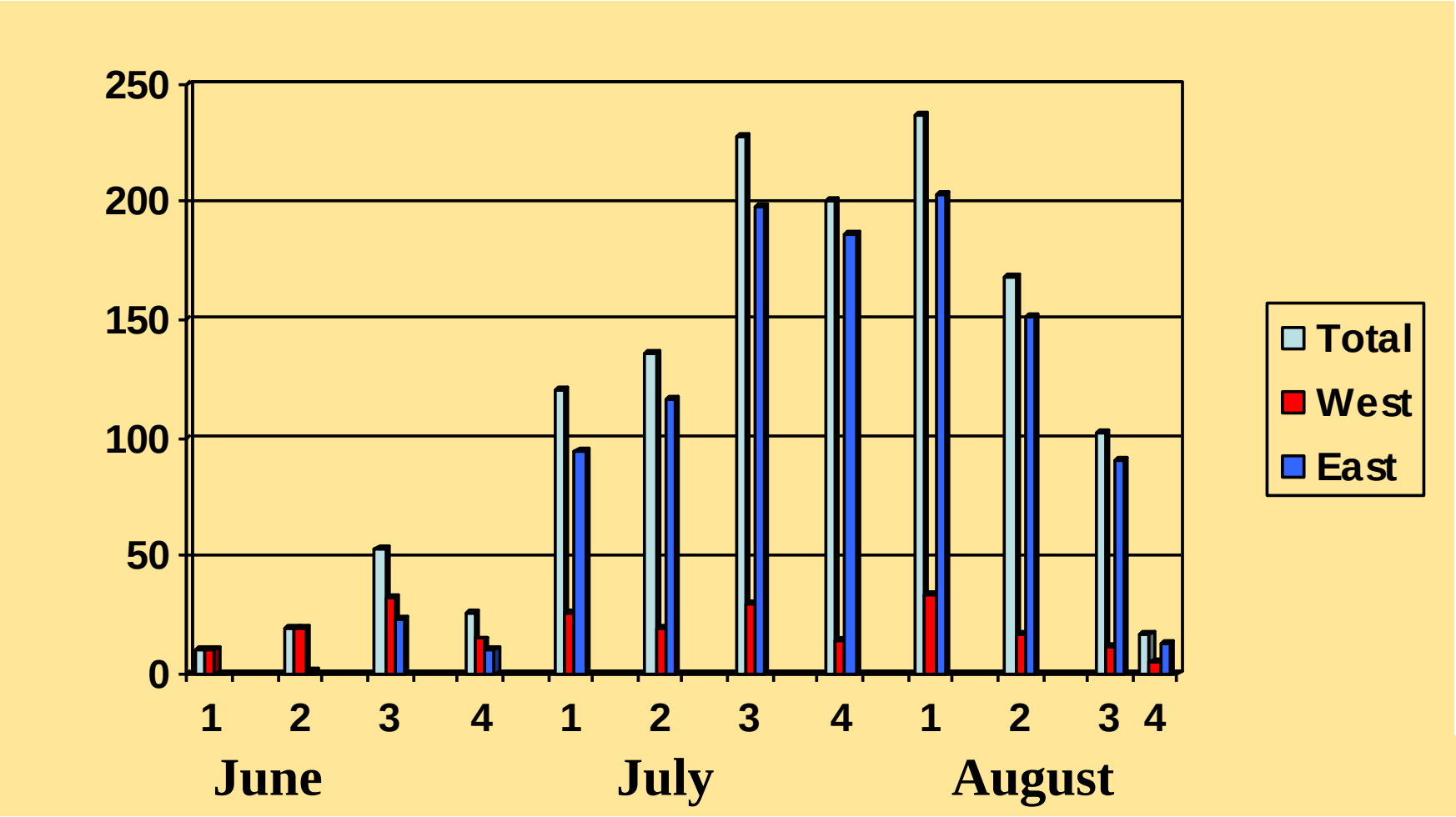
Cx. tarsalis

- **Overwinter as adults**

- **Oviposits in fresh, standing water with vegetation (sloughs, wetlands, oxbows, irrigated fields)**



Cx. tarsalis seasonal abundance



Cx. tarsalis

- **Blood meal analyses – Medicine Lake NWR**

Cx. tarsalis

60/109 avian: 17 species

49/109 mammalian: 4 species

Ae. vexans

9/78 avian: 2 species

69/78 mammalian: 4 species

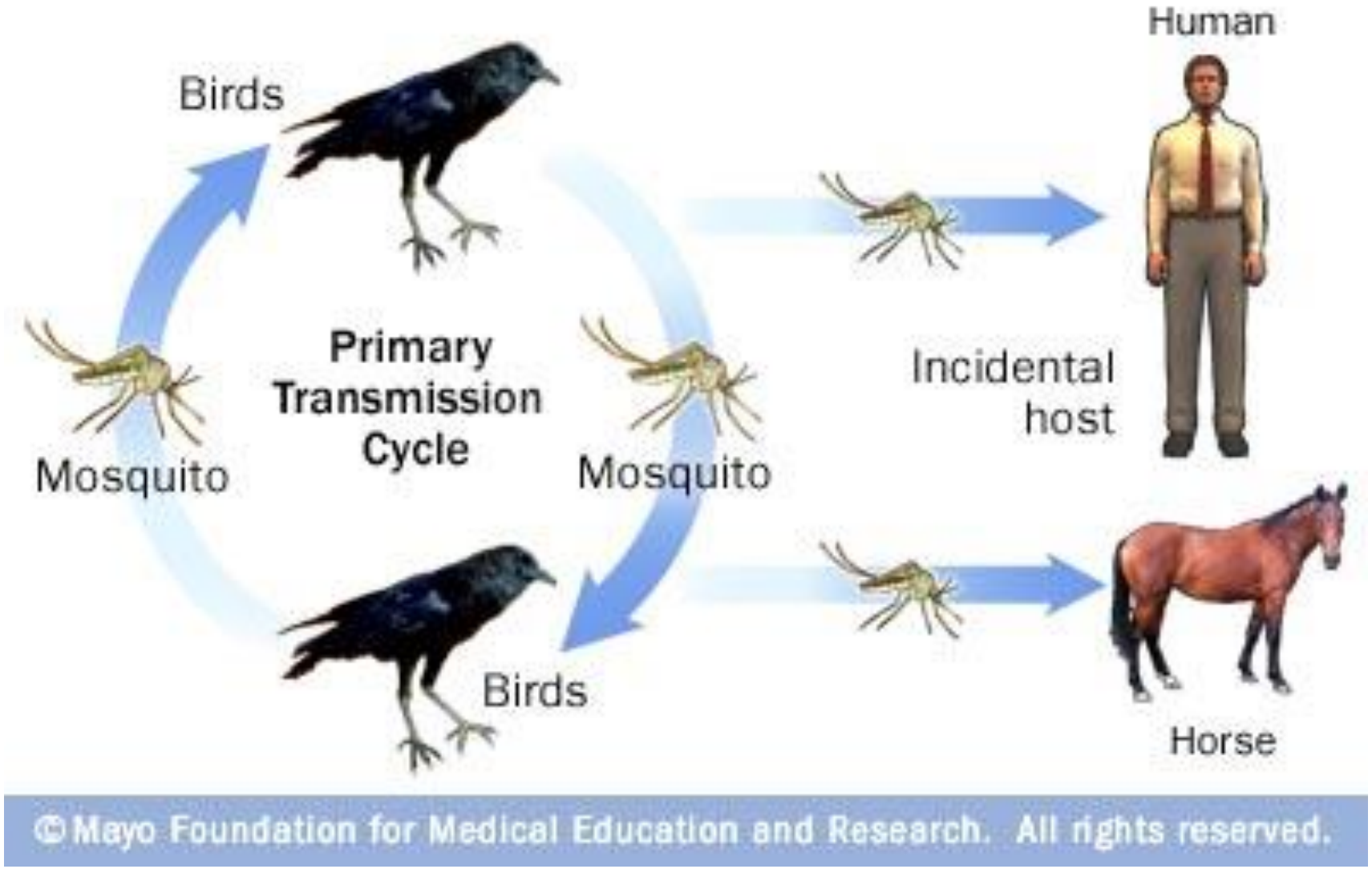
Cs. inornata

4/38 avian: 4 species

34/38 mammalian: 3 species

(Johnson et al. 2010. EID. 16:406-411, Friesen and Johnson. 2013. JAMCA . 29:102-107)

West Nile Virus



Factors that regulate WNV transmission

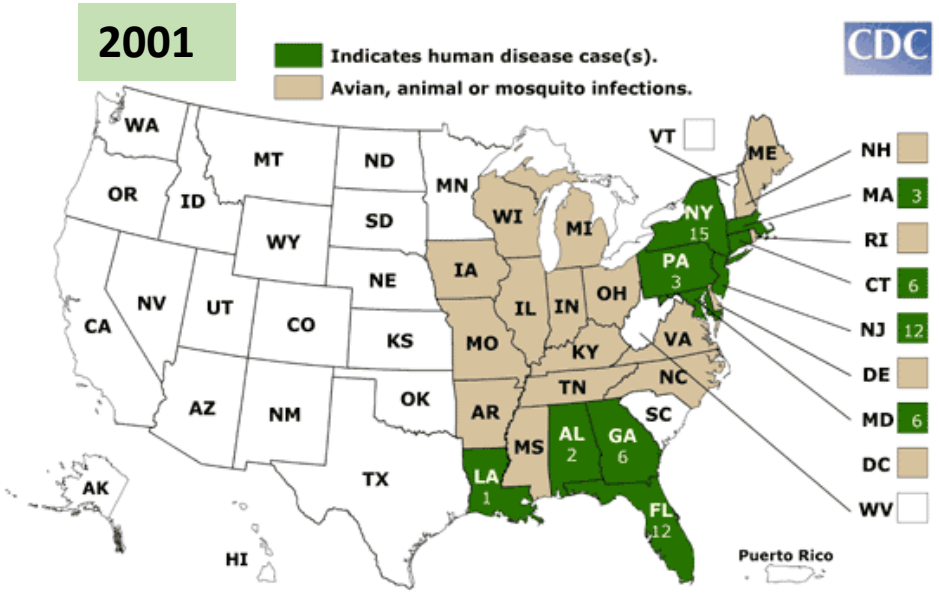
Complex interaction of biological and environmental factors

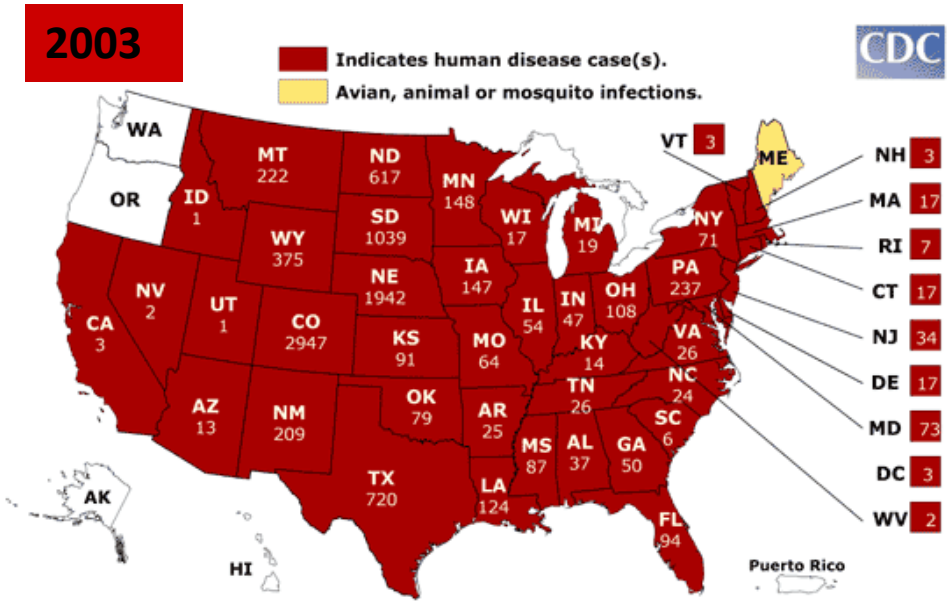
- **Biological: vector species, vector density, pathogen, susceptible animal host, reservoir and amplifying hosts, etc.**
- **Environmental: temperature, precipitation, wind, RH, vegetation, landscape, etc.**
- **Timing and convergence of biological and physical factors is critical for an outbreak to occur.**

(Gage et al. 2005. Am J Prev Med. 35: 436-450)

West Nile Virus

- 1999-2004
  - Invasive phase
  - Chxt by explosive outbreaks
- 2002
  - 1st entered plains states
- 2003
  - Massive epidemic
  - U.S. approximately 10,000 human cases
  - Montana 222 cases, 4 deaths





West Nile Virus

- **Equilibrium phase, 2005 – present**
- **Dampening of infection in birds and mammals**
  - **Recovery and survival**
- **Overall human cases declined in U.S.**
  - **Periodic, focal outbreaks**
  - **Montana 2007**
  - **U.S. 2012**

Montana WNV human case report

Year	Total	Fatalities
2002	2	0
2003	222	4
2004	6	0
2005	25	0
2006	34	0
2007	202	4
2008	5	0
2009	5	0
2010	0	0
2011	1	0
2012	6	1

West Nile Virus

- **> 300 species of birds killed**
- **WNV strain NY99 was more virulent to birds than Isr98 strain.**
- **Mid-west – corvids (crows and jays) became a hallmark of WNV transmission.**
- **Montana - hallmark species are greater sage-grouse and American white pelican**

WNV - Montana

Medicine Lake NWR

- **Vector**
  - **Extensive habitat for *Cx. tarsalis***
- **Reservoir and amplifying hosts**
  - **125 species of migratory birds**
  - **Opportunity to introduce virus**
- **Susceptible animal hosts**
  - **2,000 pelican chicks, shorebirds, waterfowl, etc.**
- **Biological and environmental factors conducive to amplification and transmission**

AWP Mortality

Year	LTI	Pools + # tested	MIR/1,000	Vector Index	Chick Mortality
2005	108	5/68	1.4	1.1	400
2006	6	2/64	0.6	0.4	385
2007	438	28/87	7.3	3.2	450
2008	12	1/9	2.2	2.4	<50
2009	35	5/145	0.7	0.4	113
2010	23	0	0	0	<50
2011	181	1/400	0.2	.03	<50
2012	--	--	--	--	<50
2013	--	13/54	--	--	250+

WNV Transmission

- ***Cx. tarsalis*** **may trigger the WNV epizootic**
- **Chick behavior may contribute to explosion**
  - **Chicks can amplify WNV**
  - **Bird to bird contact**
  - **Oral and cloacal swabs indicate viral shedding**
- **Other ectoparasites**
- **Pelican lice, other mosquito species, stable flies, soft ticks**

(Johnson et al. 2010. EID, Johnson et al. 2010. J. Med. Ent.)

WNV Immunity

- **Pre- and post-WNV exposure 2006 – 2008**
  - **Medicine Lake, Chase Lake and Bitter Lake**
  - **350 3 wk old chicks 5% + for WNV antibodies**
  - **259 post WNV exposure, 39% + for WNV antibodies**
- **More variability in chick mortality which might suggest immunity is developing**
- **Significant number of chicks appear to be surviving infection**
- **Frequent exposure to WNV?**

WNV population impacts

- **Pelicans initially greatly impacted by WNV**
- **2008 – 2012 more variability in chick mortality**
  - **Is this an increase in resistance or immunity to WNV infection?**
  - **Or due to other biological or environmental factors?**
- **Wildlife biologists are making cautious predictions**
- **Long lived species with low reproductive potential**

WNV in Greater Sage-Grouse

<u>WNV cycle</u>

- ***Cx. tarsalis* primary vector in sagebrush habitat**
  - **Bird-to-bird transmission possible**
  - **Other arthropod species unlikely**
- **Virus source migratory and resident birds (passerine)**
- **Amplifying host**
  - **Species are unclear but may involve sage-grouse**
- **Ideal weather pattern**
  - **Wet spring, hot summer, drought conditions**

WNV in Greater Sage-Grouse

Mortality

- **Confirmed in 10 states and 1 province**
- **Radio-collared and unmarked birds**
- **Mortality estimates w/o confirmation skeptical**

Immunity

- **High mortality rates during WNV outbreaks**
- **Low levels of immunity to WNV infection in captive and wild birds**
- **MT/WY**
  - **2005, 10% seropositive birds (58)**
  - **2006, <2% seropositive (109)**
- **Resistance to infection projected to increase slowly in the future**

WNV in Greater Sage-Grouse

Population impacts

- **Significant declines reported in local/regional populations**
- **Represents a continued risk to sage-grouse populations**
- **Distribution of *Cx. tarsalis* and WNV is not continuous across the landscape**
- **Unexposed birds can repopulate local affected areas when overall populations are high**

Mosquito Management

- **Difficult but not impossible to achieve in rural landscape**
- **Sites are numerous, may be difficult to find and access**
- **Insecticides are effective but require monitoring; timing of application is important**
- **Modifying sites can be effective but may result in producing habitat suitable for other pests or vectors**

Future Prediction

- **WNV is here to stay**
- **Represents a continued risk to sage-grouse populations**

To facilitate protection:

- **Identify areas of Cx. tarsalis production and monitor for WNV transmission**
- **Monitor bird populations for mortality and survival**
- **Develop mosquito management programs in sage-grouse areas highly vulnerable to WNV transmission**